TITLE OF THE INVENTION

METHOD FOR FINDING THE POSITION OF A SUBSCRIBER IN A RADIO COMMUNICATIONS SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and hereby claims priority to German Application No. 10305091.4 filed February 7, 2003 and European Application No. 03002821.1 filed February 7, 2003, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] One possible aspect of the invention relates to a method for finding the position of a subscriber in a radio communications system.

[0003] In radio communications systems, arrangements with base stations and antenna devices are known, in which transmission signals from two or more subscribers are combined to form a transmission sum signal, and this transmission sum signal is passed by cables from the base station to at least two spatially distributed antenna devices for transmission. On the other hand, radio received signals from subscribers, which are received via the antenna devices, are combined to form a received sum signal, which is transmitted by cables to the base station.

[0004] When using glass fiber cables for cable transmission, the sum signals mentioned above are in general produced by analog modulation of a semiconductor laser.

[0005] Furthermore, methods are known for finding the position of a subscriber in a mobile radio communications system, which methods find the position of a subscriber via transceivers, with the aid of delay time measurements. Examples of this are position-finding methods in a GSM mobile radio system, based on the so-called “timing advance mechanism”.

[0006] However, a method such as this cannot be used in the radio communications system as described above, in which base stations are used with spatially distributed antenna devices, since multipath propagation and the reception situation mean that only ambiguous positions can be found. These ambiguities could be minimized only by using costly additional transceivers.

SUMMARY OF THE INVENTION

[0007] One possible object of the present invention is therefore to specify a cost-effective method for finding the position of a sought subscriber in a radio communications system, in which a base station is associated with at least two antenna devices for signal reception. .

[0008] In the method proposed by the inventor, glass fiber cables are preferably used for signal transmission – both at the transmission end and at the reception end. Owing to the very low attenuation levels, the individual cable lengths, and the differences which can be found between the cable lengths can be chosen such that ambiguities in the delay time measurement to be carried out can be avoided, provided that the signal quality is good.

[0009] In the method, the position-finding process is based on a so-called "round trip" delay time measurement as is described, for example, in "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Physical Layer – Measurements (FDD), Release 4", 3GPP TS 25.215, v4.5.0 (2002-09), section 5.2.8, or in "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Requirements for Support of Radio Resource Management (FDD), Release 4", 3GPP TS 25.133, v4.6.0 (2002-09), section 5.2.8, section 9.2.8.

[0010] In this case, a subscriber-specific signal is transmitted, for example, from a base station to a subscriber, from where a subscriber signal is transmitted back for acknowledgement purposes to the base station. In the case of a "round trip" delay time measurement, the overall delay time of these signals between the base station and the subscriber is determined.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] These and other objects and advantages of the present invention will become more apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawing of which the figure shows a base station BTS with spatially distributed antenna devices ANT1 to ANT3 for carrying out the position-finding process according to one aspect of the invention.

[0012] In the following text, glass fiber cables GFK are used for signal transmission between the base station BTS and the three antenna devices ANT1 to ANT3.

[0013] In the base station BTS, and transmission signals SS1 from a first subscriber TN1 are combined with a transmission signal SS2 from a second subscriber TN2 and with a transmission signal SS3 from a third subscriber TN3 to form a transmission sum signal SSUM. The transmission sum signal SSUM is passed via a glass fiber cable GFK to all three-antenna devices ANT1 to ANT3 for transmission.

[0014] In this case, a first antenna device ANT1, for example in an indoor radio communications system, is assigned a first area R1 of a building G for its radio supply, in which the first subscriber TN1 is located. In a corresponding manner, a second and a third antenna device ANT2 and ANT3, respectively, are assigned to a second and a third area R2 and R3, respectively, for providing the radio supply to the second and third subscriber TN2 and TN3.

[0015] The transmission sum signal SSUM which is transmitted via the antenna devices ANT1 to ANT3 is received by the subscribers TM1 to TM3, and the transmission signal SS1 to SS3 which is intended for the respective subscriber TN1 to TN3 is determined on a subscriber-specific basis from the transmission sumsignal SSUM.

[0016] In a corresponding manner, signals SIG1 to SIG3 which are transmitted by the subscribers TN1 to TN3 are received as the received signals ES1 to ES3 via the respective antenna devices ANT1 to ANT3 which are associated with the subscribers TN1 to TN3, and are combined to form a received sum signal ESUM. The received sum signal is in turn passed via a glass fiber cable GFK to the base station BTS, for further processing.

[0017] Both the transmission-end and the reception-end sum signal transmission are carried out particularly advantageously with the aid of a common connecting cable.

[0018] Individual cable lengths LNG1 to LNG3 are now chosen for each individual antenna device ANT1 to ANT3 such that, based on a round trip delay time measurement which is carried out on a subscriber-specific basis, it is possible to uniquely determine an antenna device ANT1 to ANT3 which is associated with the respective subscriber TN1 to TN3.

[0019] Unique determination is possible, for example, by choosing a length difference $\Delta(i)$ between individual cable lengths LNG(i+1) and LNG(i) of adjacent antenna devices ANT(i+1) and ANT(i) using the following formulae:

$\Delta = LNG(i+1) - LNG\ (i) \geq Const$, where

$Const = r*v/c$

where:

i is a sequential variable to identify a cable length LNG which is associated with an i-th antenna device,

r is the range of a radio supply area,

v = 2*10E8 m/s is the glass fiber group velocity, and

c = 3*10E8 m/s is the group velocity in air.

[0020] By way of example, the cable length LNG(i) of an i-th cable is chosen to be:

LNG(i) = i * Const

[0021] When the signal delay time t is:

2*i*Const/v < t < 2*(i+1)*Const/v

ambiguities are avoided in the delay time measurement to be carried out, and a subscriber can be uniquely associated with an i-th antenna device.

[0022] On the assumption that the maximum cell size, as the range of an antenna device, is, for example, r = 300 m, this means that, on the basis of the above formula for the supply line cables for adjacent antenna devices, the minimum required length difference is:

$\Delta(i) = LNG(i+1)-LNG(i) \geq Const$

$\Delta(i) \geq 200$ m.

[0023] A glass fiber has typical attenuation levels of about 0.2 dB/km, so that the laying of additional cable lengths does not involve any additional attenuation problem.

[0024] A glass fiber cable path with the following individual supply line length LNG1 is chosen for the first antenna device ANT1:

LNG1 = 600 m

[0025] Glass fiber cable paths with the individual supply line lengths LNG2 and LNG3 for the second and third antenna devices ANT2, ANT3 are as follows:

LNG3 = LNG2 + Δ = 1000m

LNG2 = LNG1 + Δ = 800 m.

[0026] A round trip delay time measurement is carried out, on a representative basis, for the first subscriber TN1, and, based on the delay time differences which are caused by the length differences between the glass fiber cable paths, the first antenna device ANT1 is determined to be the receiving antenna that is associated with the first subscriber TN1.

[0027] The result of this is that the area R1 which is associated with the first antenna device ANT1 for radio supply is determined to be the position of the first subscriber TN1.

[0028] Distributed antenna devices are typically used for the radio supply for so-called Piko radio cells within an indoor radio communications system.

[0029] The invention has been described in detail with particular reference to preferred embodiments thereof and examples, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.